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Toward the azimuthal characteristics of ionospheric and seismic effects of "chelyabinsk" meteorite fall according to the data from coherent radar, GPS, and seismic networks

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Abstract

©2015. American Geophysical Union. All Rights Reserved. We present the results of a study of the azimuthal characteristics of ionospheric and seismic effects of the meteorite 'Chelyabinsk,' based on the data from the network of GPS receivers, coherent decameter radar EKB, and network of seismic stations, located near the meteorite fall trajectory. It is shown that 6-14 min after the bolide explosion, GPS network observed the cone-shaped wavefront of traveling ionospheric disturbances (TIDs) that is interpreted as a ballistic acoustic wave. The typical TIDs propagation velocity were observed 661 ± 256 m/s, which corresponds to the expected acoustic wave speed for 240 km height. Fourteen minutes after the bolide explosion, at distances of 200 km, we observed the emergence and propagation of a TID with annular wavefront that is interpreted as gravitational mode of internal atmospheric waves. The propagation velocity of this TID was 337 ± 89 m/s which corresponds to the propagation velocity of these waves in similar situations. At EKB radar, we observed TIDs in the sector of azimuthal angles close to the perpendicular to the meteorite trajectory. The observed TID velocity (400 m/s) and azimuthal properties correlate well with the model of ballistic wave propagating at 120-140 km altitude. It is shown that the azimuthal distribution of the amplitude of vertical seismic oscillations with periods 3-60 s can be described qualitatively by the model of vertical strike-slip rupture, propagating at 1 km/s along the meteorite fall trajectory to distance of about 40 km. These parameters correspond to the direction and velocity of propagation of the ballistic wave peak by the ground. It is shown that the model of ballistic wave caused by supersonic motion and burning of the meteorite in the upper atmosphere can satisfactorily explain the various azimuthal ionospheric effects, observed by the coherent decameter radar EKB, GPS receivers network, and the azimuthal characteristics of seismic waves at large distances.

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Keywords

azimuthal asymmetry, ballistic wave, Chelyabinsk meteorite, ionospheric effects, seismic effects